

Ground System Testing

GS SDR Section 17

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Ground System Engineering



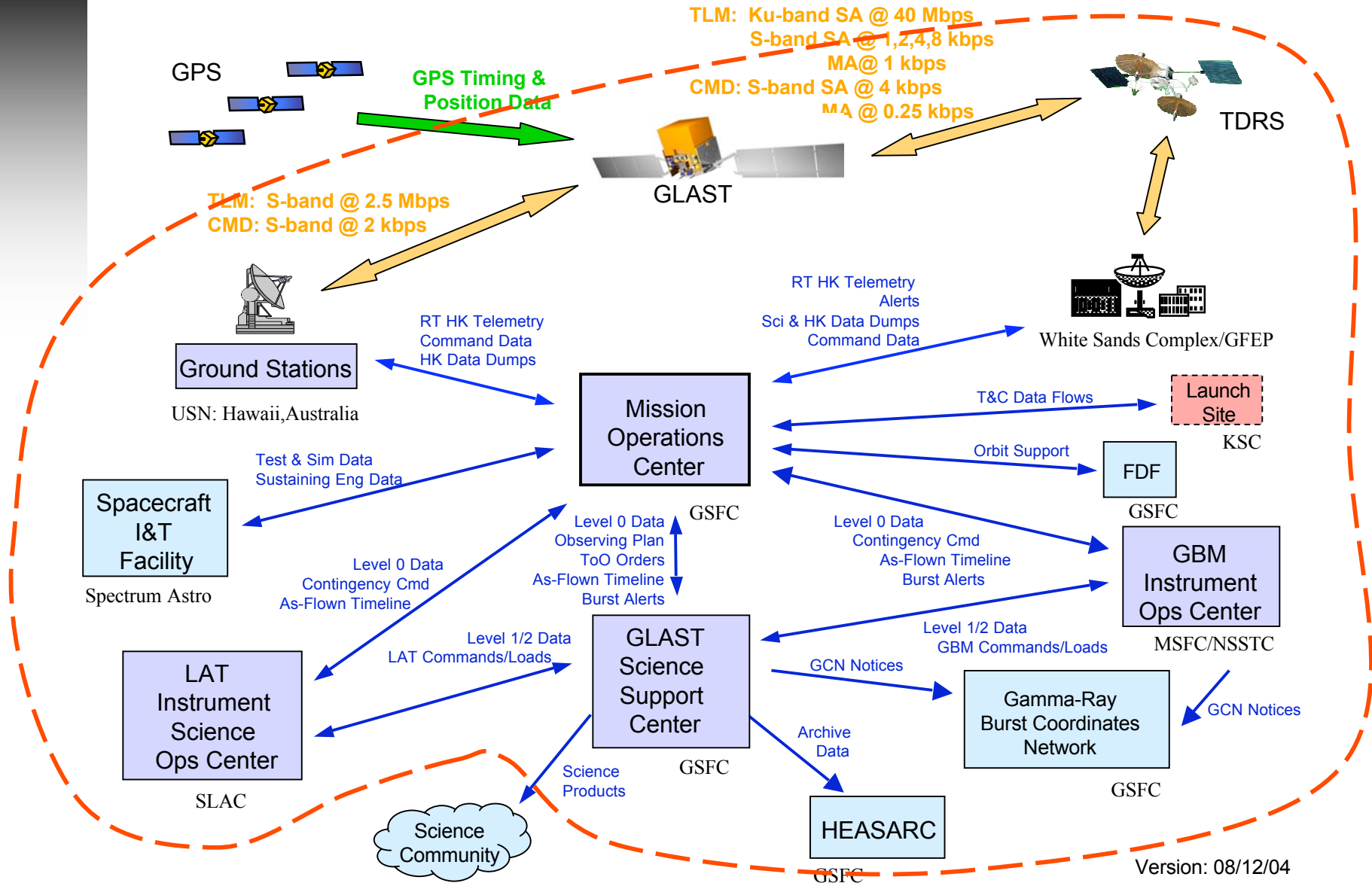
Outline



- ▶ **Ground System Architecture**
- ▶ **Roles and Responsibilities**
- ▶ **Ground System Test Approach**
- ▶ **Test Planning and Management**
- ▶ **Requirements Verification Roll-Up**
- ▶ **GSRD Requirements Tracking**
- ▶ **Simulators and Test Data**
- ▶ **Verification Test Overview**
 - *RF Compatibility Testing*
 - *Ground Readiness Testing*
 - *End to End Testing*
- ▶ **Discrepancy Management/Tracking**
- ▶ **Schedule**
- ▶ **Backup**



Ground System Architecture



Version: 08/12/04



Test Roles & Responsibilities

- ▶ ***Test planning, coordination, and conduct led by the Ground System Test Lead, under direction of the Ground System and Operations Manager (GSOM)***
- ▶ ***Spectrum Astro plays lead role in approving what activities can and should be performed with the observatory***
 - *Spectrum determines what commands are allowed to be sent to the observatory during the test – will monitor test progress and can “pull the plug” at any time deemed necessary*
 - *Spectrum Astro will execute the RF Compat tests in conjunction with CTV support*
- ▶ ***Instrument teams are responsible for supporting their respective instruments during testing and will provide support through the ISOC/IOC Leads***
 - *Example: IOTs will provide personnel at the Spectrum I&T Facility or the MOC as required to monitor instrument operations during ETE testing*
- ▶ ***FOT responsible for planning, documenting, and executing (from the MOC) the Ground Readiness Tests and End-to-End tests***
 - *FOT will also generate briefing and debriefing messages*



Personnel Roles and Responsibilities



- ▶ **Ground System and Operations Manager (GSOM) – Ken Lehtonen/ Code 581**
 - *Ensures that the ground system requirements, interfaces, and design are developed and documented, and is ready to support GLAST launch by the launch freeze date*
 - *Ensures that the individual elements have been implemented and that the elements individually and the ground system as a whole has been validated as meeting all critical requirements*
- ▶ **Ground System Test Lead – Beth Pumphrey/ Code 586**
 - *Administers the Ground System Test Program*
 - *Develops and maintains the appropriate test program documentation, and chairs the Ground Readiness Test Team (GRTT) meetings*
 - *Coordinates the Ground Readiness Tests and ETE Tests*
 - *Maintains the Ground System Test Verification Matrix*
 - *Schedules resources as necessary for individual tests*



Personnel Roles and Responsibilities



► **Ground System Engineering Support**

- *Assists the GSOM in the technical management of the ground system development effort.*
- *Chairs the GLAST Ground System Discrepancy Review Board (DRB) once ground system testing begins.*
- *Ensures the Ground System is ready to meet test readiness objectives*
- *Maintains the MOC to Observatory Checklist for ETE tests*

► **Element Leads**

- *All Ground System Element leads will be active participants in ensuring their element is capable of supporting the test objectives laid out by the Ground System Test Lead*
 - *This includes timely completion of element level testing, build capabilities and resource availability*
 - *Coordinates element builds/releases to achieve GRT objectives*



Ground System Test Approach



- ▶ **Testing is limited to verifying the functionality, performance and interfaces of the Ground System as defined in the GSRD (Baseline 08/03)**
 - GSRD covers Ground Communications, SN, USN, MOC, LAT ISOC and GBM IOC, GSSC, HEASARC, GCN, Spacecraft I&T Facility, FDF and KSC
 - Test participation will include the above elements as necessary
 - Resources include spacecraft and simulators (PSS, MTS, HotBench, and SDMS)
 - Testing will include Element Level, RF compatibility, Ground Readiness Test, and End-To-End
- ▶ **Ground System Test Plan describes the overall plan for ground system testing and the describes the tests demonstrating the ground system's readiness to support the GLAST mission**
 - Identifies the configuration, team members roles and responsibilities for implementation of each test
 - Contains dependencies and objectives
 - Specifies target dates for Configuration Management of products, reviews of test script, test readiness dates



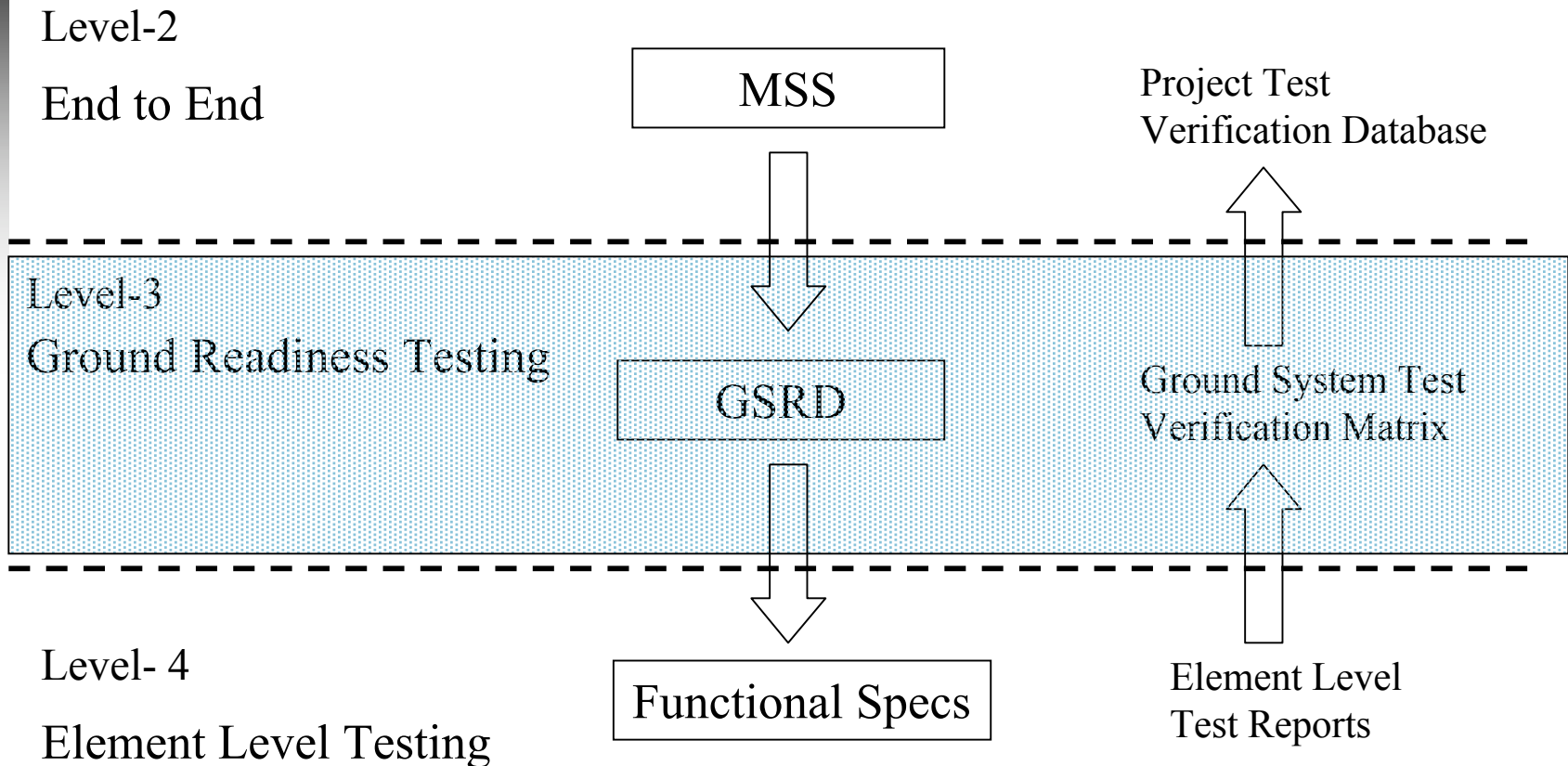
Test Planning and Management



- ▶ ***Ground Readiness Test Team (GRTT) develops the detailed plans and scripts for the ground system tests and for analyzing results of each of the tests***
 - *The GRTT will be chaired by the Ground System Test lead*
 - *The GRTT will include representatives of all elements of the Ground System*
- ▶ ***Test Script will be generated for each test that will provide more detail than is documented in the high level Ground System Test Plan***
 - *Test Plan provides objectives, the Test Script provides the specific step-by-step details for test conduct and the products needed*
- ▶ ***Briefing Messages will be distributed to ensure that all test participants have the information needed to conduct the test***
 - *Used to schedule institutional resources such as SN support*
- ▶ ***The GRTT will track results of the test, provide a Test Report that will be distributed to the project to document the results (e.g. requirements passed/failed, discrepancies found)***



Requirements Verification Roll-Up





Requirements Verification Roll-Up



- ▶ ***The GLAST Project Systems Manager maintains the system-level Project Test Verification Matrix***
 - *Project Test Verification Matrix tracks progress and status across all of the mission components at the MSS level (Level-2)*
 - *Input from Observatory I&T, GRT and ETE testing*
 - *The Ground System Requirements Verification Matrix tracks the status all GSRD requirements (Level-3)*
 - *Traces to the MSS*
 - *MSS requirements not satisfied by Observatory I&T or GRT is performed during ETE*
 - *Element Level Test Reports tracks the status of the Functional Specifications Requirements*
 - *Traces to the GSRD for Ground System Requirements*
 - *Elements demonstrate that level-4 requirements that trace GSRD have been tested and satisfy the test objectives prior to GRT*
 - *Ground System Test Plan is in compliance with the GLAST Project Office System Verification Plan*



GSRD Requirements Tracking

- ▶ **Ground System Test Lead will generate and maintain a Ground System Requirements Verification Matrix for the GRTs**
 - *Matrix will be the primary vehicle to record specifically what will be tested (i.e. the test requirements), when it will be tested, and the status of each of the test requirements*
 - *The GRTT reviews the requirements matrix and maintains test status and progress*
 - *Requirements Verification Matrix will be maintained on the GLAST Ground System Web*
- ▶ **Ground System Requirements Verification Matrix developed by Ground System Engineering**
 - *Requirement contains ID and text, with trace to MSS for systems verification, whether requirement is launch critical or mission critical*
 - *Verification Method tracks method used for testing (e.g. Test, Inspection, Analysis or Demonstration) and what tests are used to verify requirement*
 - *Results contains synopsis of discrepancies, passed or failed status, tester signature*

Requirement				Planned Verification							Results		
ID	Text	MSS Source ID	Critical	Test						Method	Comment	Status	Sign
				G1	G2	G3	G4	G5	ETE				



Simulators and Test Data



- ▶ ***The GRTT has at its disposal several simulator tools that will be used in the execution of the Ground System Test Plan***
 - *The primary simulator to be used for Ground Readiness Testing is the PSS*

Simulator	Provider	Use	Schedule
Portable Spacecraft Simulator (PSS)	GSFC Code 583	Initial MOC testing, Ground System Testing	October 15, 2004
MOC Training Simulator (MTS)	Spectrum	FOT training, Ops simulations, Ops product development/Test	September 30, 2005
Observatory HotBench	Spectrum and Instrument Teams	For activities requiring observatory high fidelity simulator support (e.g. selected contingency simulations and PROC validation)	To Goddard Post-launch (but available starting at S/C I&T)
Software Development and Maintenance Simulator (SDMS)	Spectrum	Flight software maintenance	September 30, 2005

- ▶ ***Instrument data will be captured at the packet level and transferred into frame level using the PSS – GBM data has already been ingested and tested***
- ▶ ***Data will also be recorded during instrument, spacecraft and observatory I&T for use during GRT testing***
- ▶ ***MTS will be released in 2 builds to provide early FOT access***



Verification Test Overview



► ***Ground system and mission operations readiness to be determined via series of ground system and operations tests***

– *Element Level Testing*

- *Verify functionality and performance of the individual elements that comprise the ground system*
 - *Element level functionality is verified prior to participation in GRT*
- *Demonstrate element-to-element interface compatibility*

– *RF Compatibility Tests*

- *Verify RF link between spacecraft and ground system (TDRSS & USN)*

– *Ground Readiness Tests (GRT)*

- *Verifies functionality of ground system elements and interfaces/data flows among the elements (the end-to-end ground system)*
 - *Used to exercise ground elements in as close to operational configuration as possible*
- *Demonstrates that the ground system satisfies the requirements*
- *GRTs will be designed to only use simulators and test data*

– *End-to-End Tests (ETE)*

- *Establishes ground system compatibility with the spacecraft and instruments*
- *ETE Tests will be performed using the observatory*



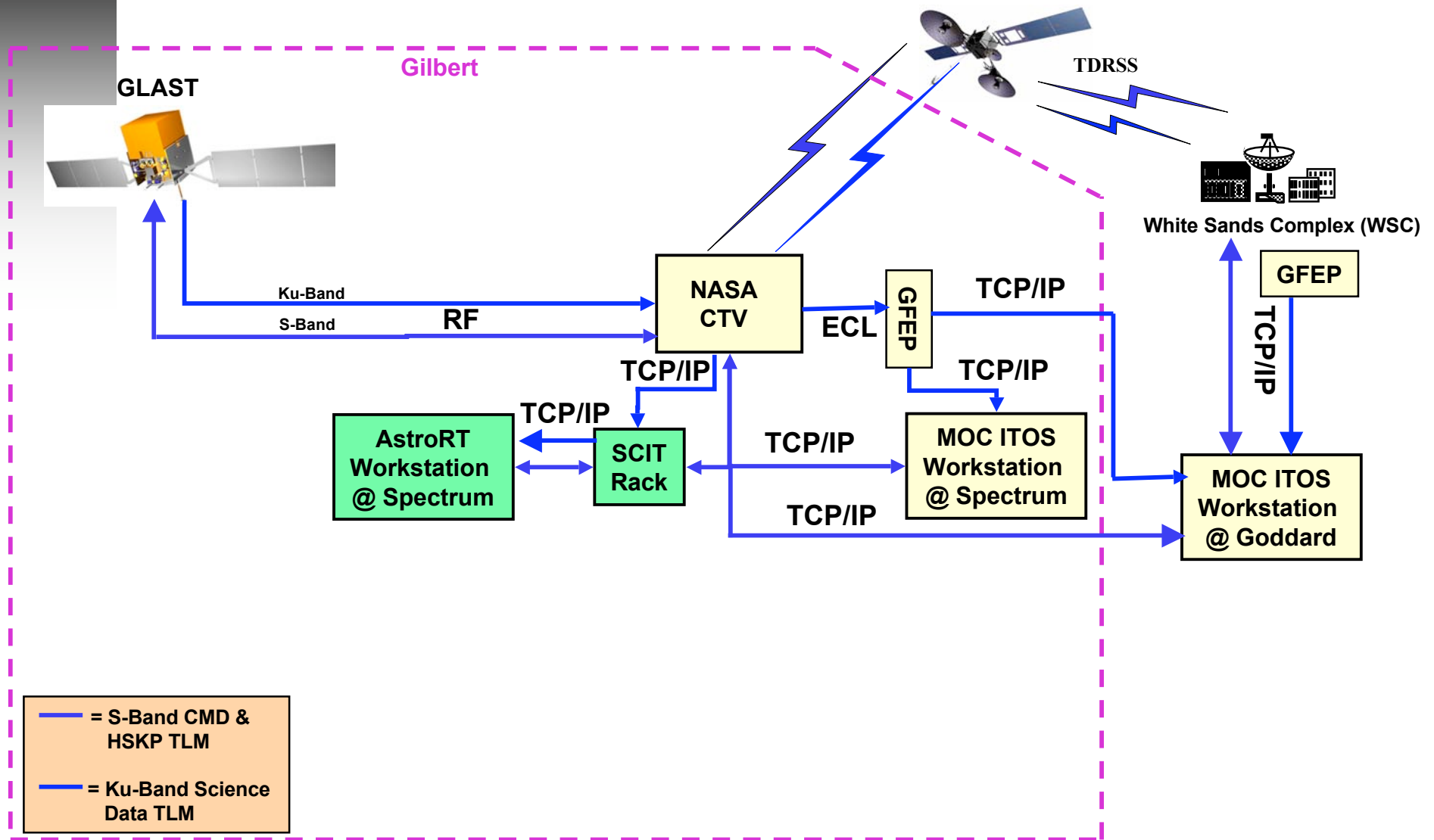
RF Compatibility Testing



- ▶ ***RF Compatibility testing validates the ability of the spacecraft and ground system RF systems to communicate***
 - *Comprised of 4 tests (5 days in length) that verify all aspects of the RF interfaces and forward and return links*
 - *Tests will assess the spacecraft RF interface compatibility with the TDRS, USN and KSC,*
 - *Measure the telemetry values at the ground station's receivers,*
 - *Verify the spacecraft command receiver operations*
 - *Will be performed by Spectrum Astro with CTV support*
- ▶ ***Verification of the RF Suitcase for USN compatibility testing is conducted using the HotBench and/or Portable Spacecraft Simulator***
- ▶ ***All RF compatibility testing will be conducted while the spacecraft is in the spacecraft contractor facility (Gilbert, AZ)***
 - *For TDRSS, CTV may also send data to GSFC MOC via TDRS/WSC*
 - *MOC workstations (approx. 2) support at Spectrum may also receive data*
 - *MOC workstations will be for FOT monitoring purposes only*

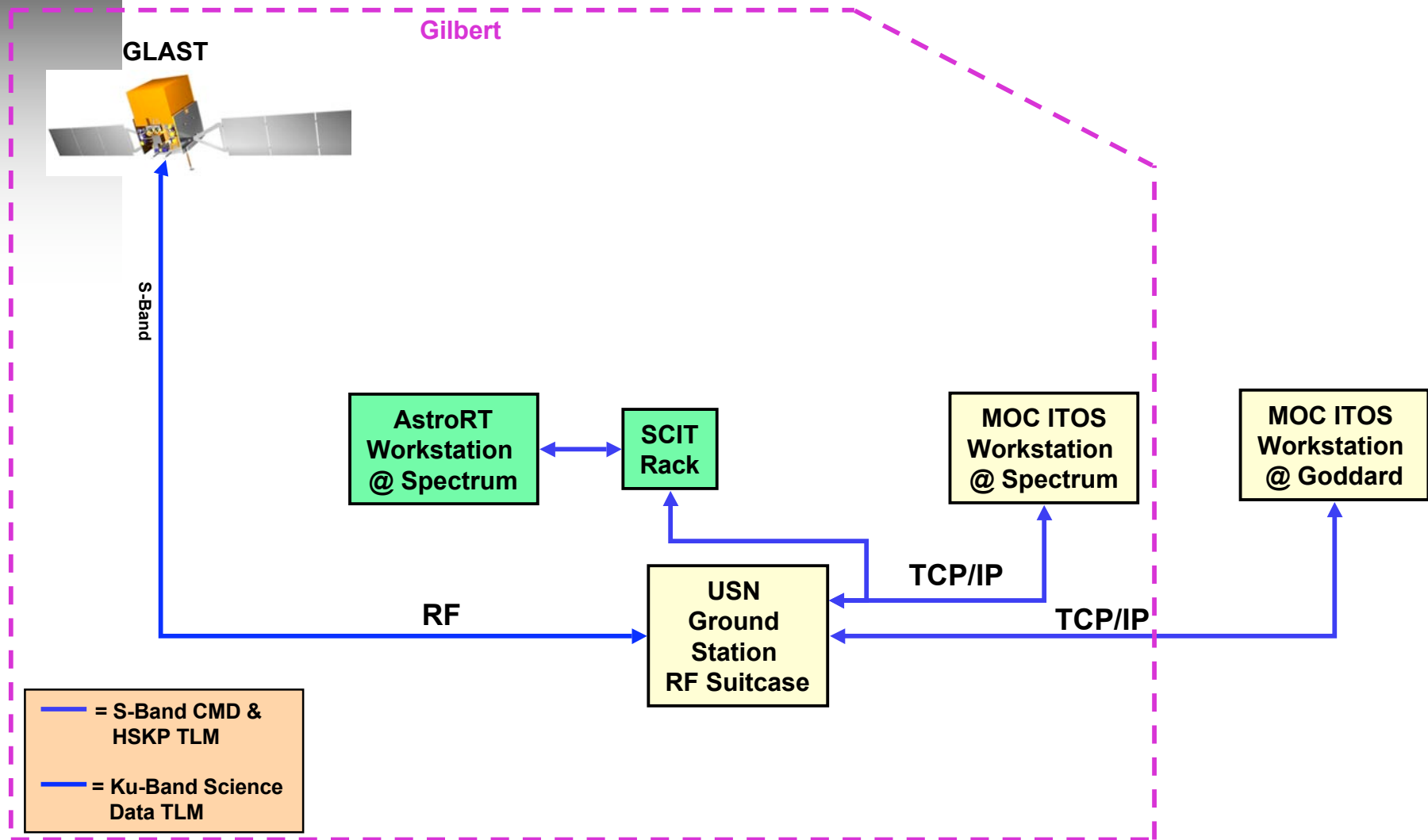


SN RF Compatibility Testing Architecture



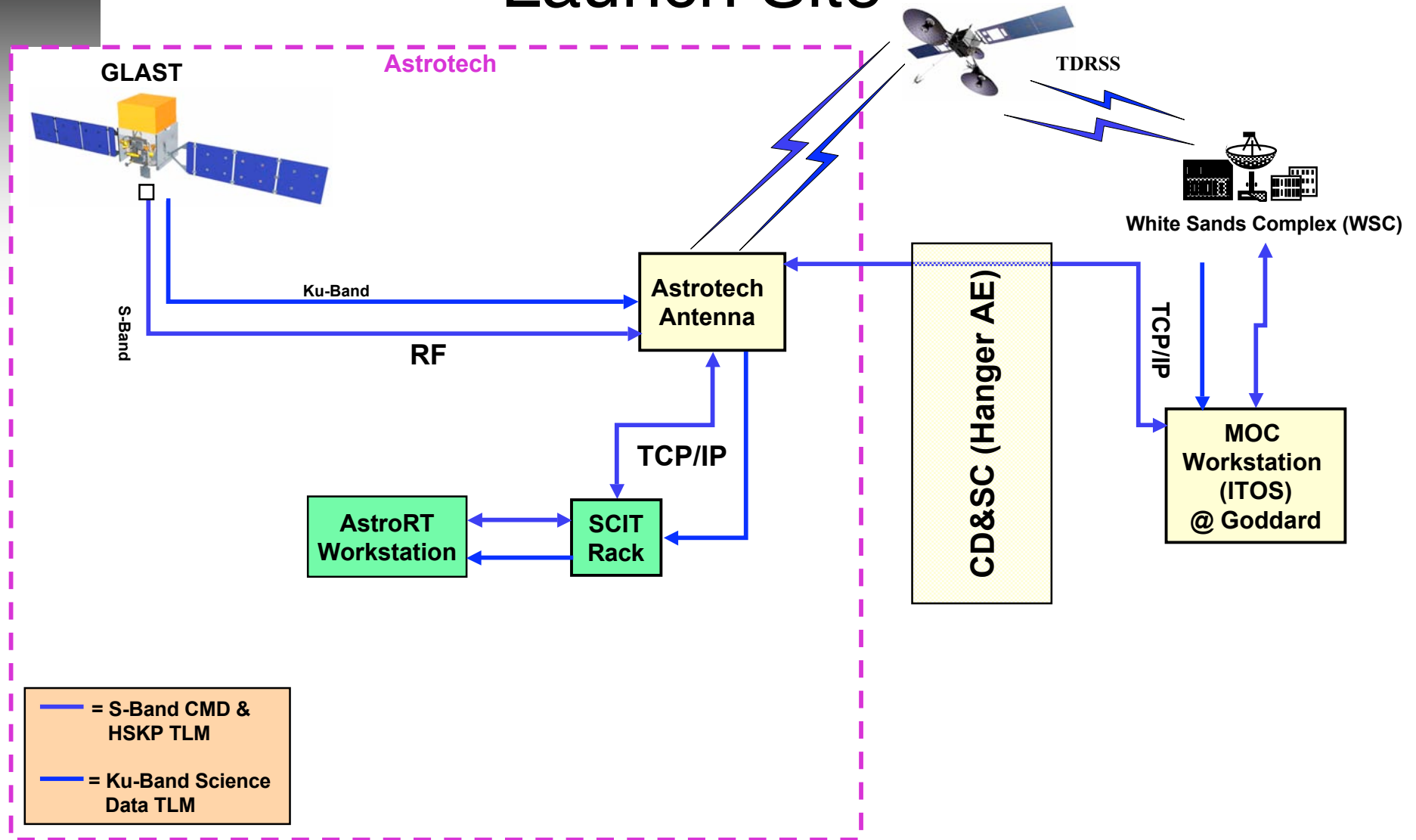
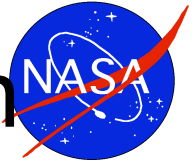


USN RF Compatibility Testing





RF Compatibility Test Configuration Launch Site





RF Compatibility Testing

- ▶ **TDRSS: Compatibility Test Van (CTV) at Spectrum Astro**
 - *The Simulations Operations Center (SOC) at GSFC and the Compatibility Test Van (CTV) will be used to communicate with TDRS and the Space Network's (SN) Demand Access System (DAS), at the White Sands Complex (WSC), and forward data to the MOC*
 - *The GLAST Front End Processor (GFEP) will be located at WSC and will be used for the Ku-band processing*
- ▶ **USN RF Compatibility Testing**
 - *USN will provide an RF suitcase that will simulate the Commercial Ground Stations*
 - *RF Suitcase will receive data from the RF transceiver on the spacecraft and process it in accordance with the signed ICD*
 - *Data will be transmitted to the MOC via the TCP/IP port on the back end of the RF Suitcase*
- ▶ **TDRSS: AstroTech antenna at KSC**
 - *Spectrum EGSE provided at KSC*
 - *Data flow back to the MOC via TDRSS link*



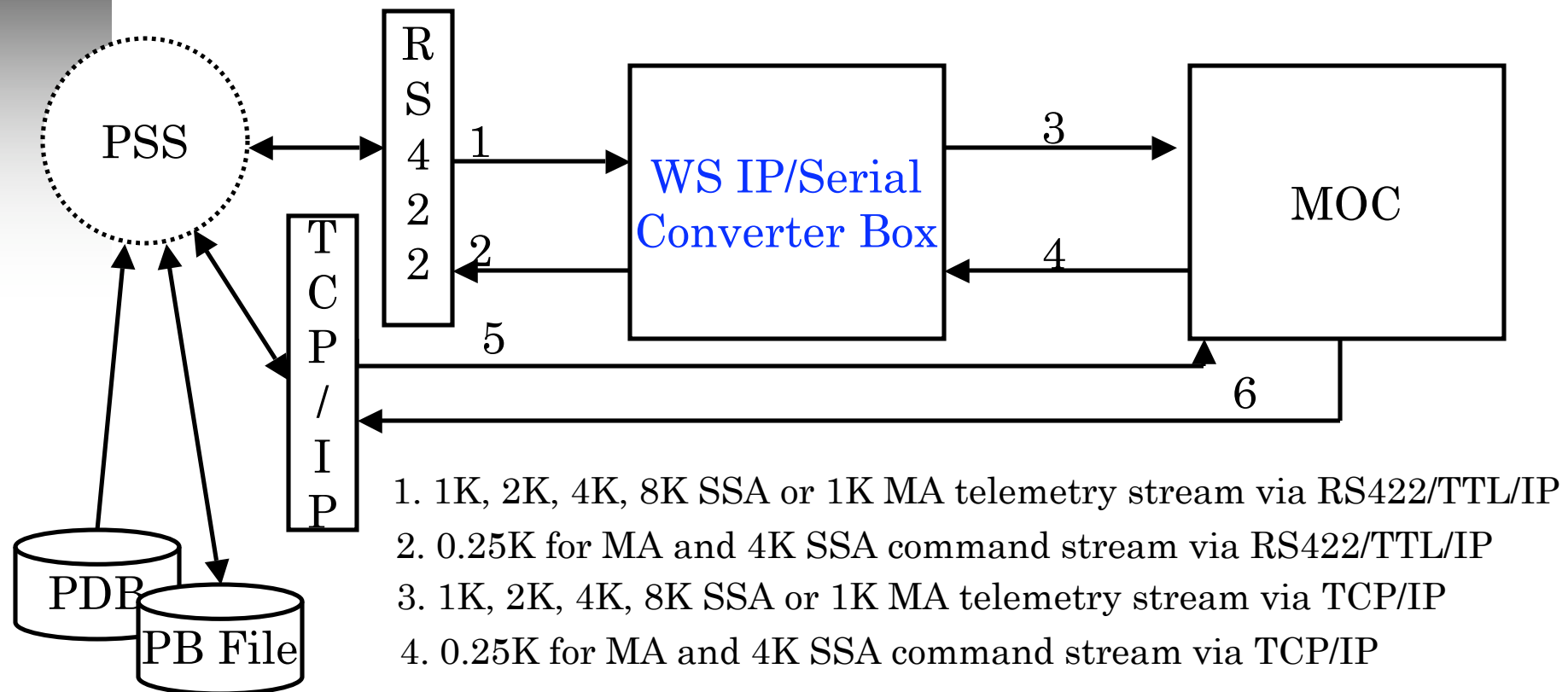
Ground Readiness Test (GRTs) Overview



- ▶ **Ground Readiness Tests (GRTs) validate the ground system interfaces, data flows, performance and major functionality of the GLAST ground system using the observatory simulators**
- ▶ **Ground System Tests will validate the primary functionality of each element and the interfaces among the elements**
 - *Formally demonstrates that the ground system meets requirements and is ready to support ops*
 - *Seven ground-system oriented tests using the simulators or recorded data (e.g. instrument frame level data) will be performed*
 - *All functionality to be tested by the first 6 tests and subsequent testing for regression testing*
 - *GSRD requirements will be tested early to allow multiple test opportunities*
 - *Tests will be executed using nominal ground system architecture configuration*
- ▶ **Ground System Element deliveries/releases will be tied to the GRTs in the Project schedule**
 - *GRTs will serve as pre-requisites to the End-to-End Tests and Sims where appropriate*
- ▶ **Each test has a theme that incorporates all of the objectives of the test and the corresponding GSRD requirements**



Simulator in SN to MOC Interface

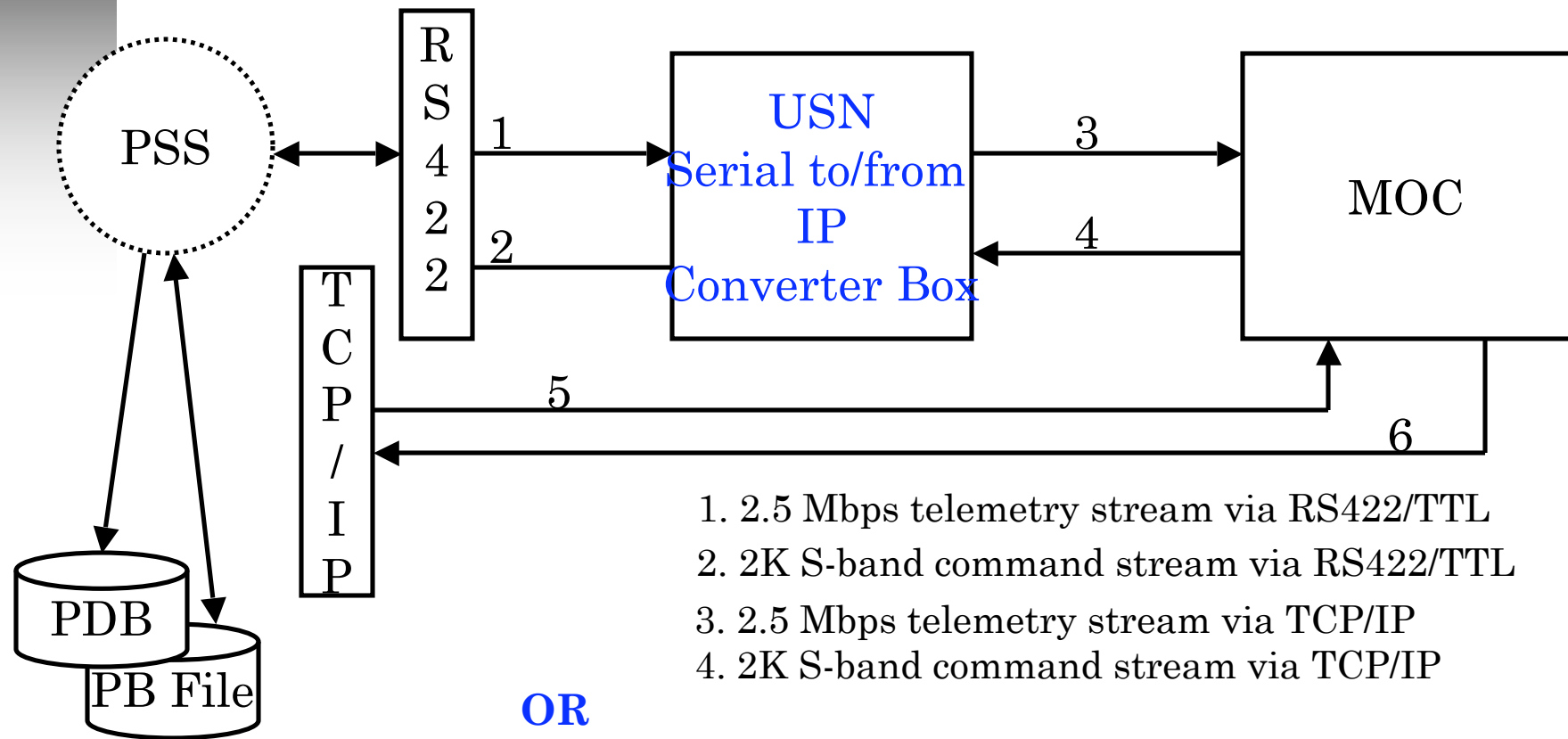


OR

- 5. 1K, 2K, 4K, 8K SSA or 1K MA telemetry stream via TCP/IP with IP header
- 6. 0.25K for MA and 4K SSA command stream via TCP/IP with IP header



Simulator in USN to MOC Interface



OR

5. 2.5 Mbps telemetry stream via TCP/IP with USN header
6. 2K S-band command stream via TCP/IP with USN header



GRT Objectives



- *GRT-1 Basic Command and Telemetry to PSS Connectivity (2/15/05)*
- *GRT-2 Basic S-Band Operations (4/15/05)*
- *GRT-3 Basic Ku-Band Operations (6/15/05)*
- *GRT-4 Ground Station Operations (9/1/05)*
- *GRT-5 Science Operations (11/15/05)*
- *GRT-6 Contingency Operations (3/15/06)*
- *GRT-7 Regression (5/15/06)*



End-to-End Test Overview

- ▶ ***End-to-End Tests are operations-oriented interface tests between the ground system and the observatory***
 - *Via a hard-line and RF interface between the spacecraft and MOC*
 - *ETE tests are to be executed using the GSFC MOC*
 - *MOC workstations available at both Spectrum facility & in GSFC MOC facility to provide test flexibility*
 - *Ensures the FOT properly understands the operations of the observatory*
- ▶ ***End-to-End Test objectives, test configuration, data flows, required test products, etc. are defined in the **Ground System Test Plan*****
- ▶ ***All PROCs used during tests must first be validated against the HotBench or MTS, and signed off by the FOT, Spectrum and Instrument Teams as appropriate***

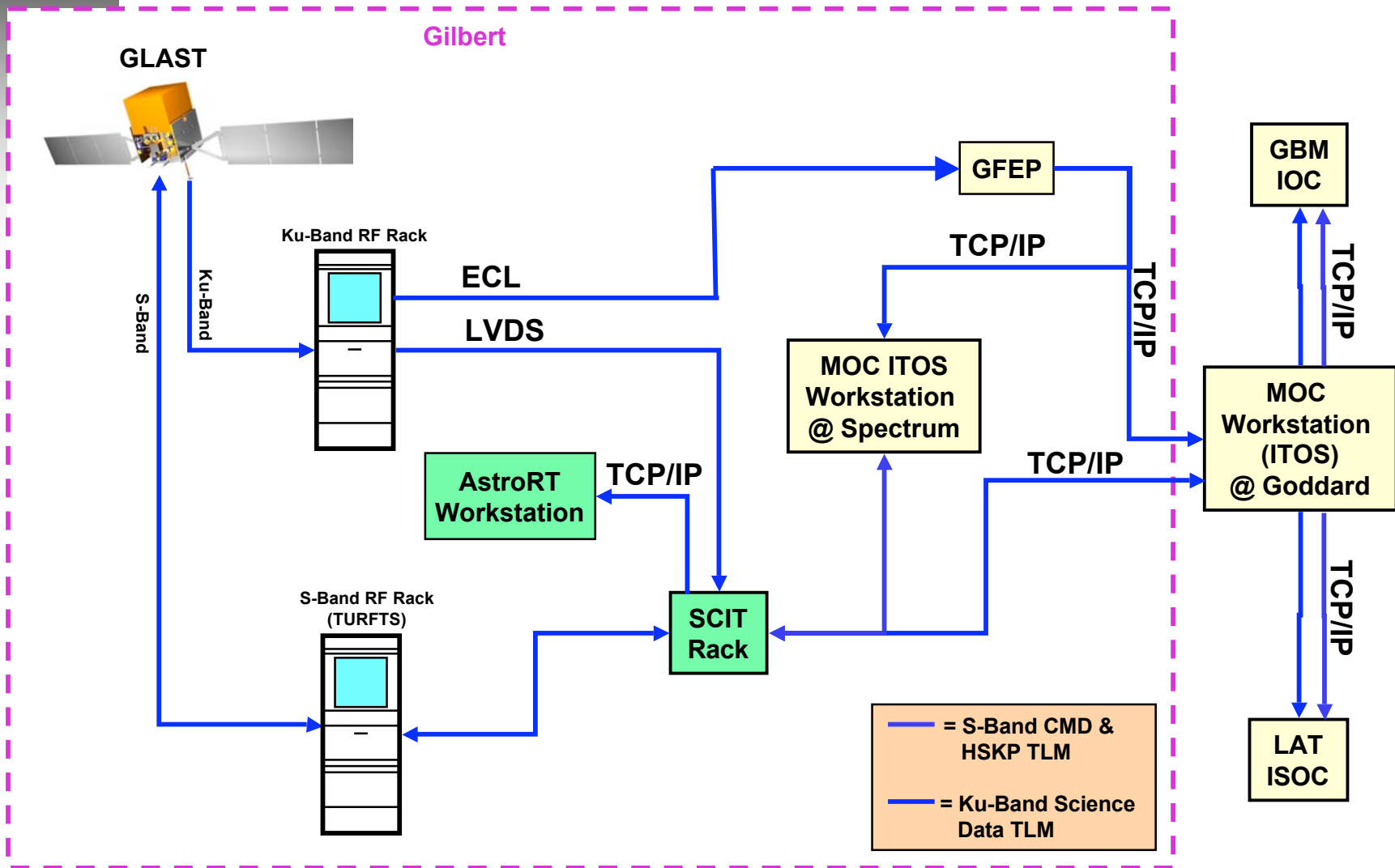


End-to-End Tests

- ▶ **Plan to conduct 5 End to End tests, with a 6th planned for the launch site**
 - *Each test currently allocated two days each on the SAI schedule*
- ▶ **Initial tests are focused on establishing MOC to observatory interface compatibility**
- ▶ **Subsequent tests will be tailored towards operational scenarios**
 - *Basic, advanced, and contingencies*
- ▶ **Test Metrics**
 - *Ground System Engineering will maintain the “MOC to Observatory Checklist”*
 - *Checklist used to ensure MOC functionality is compatible with the observatory*
 - *MSS requirements that span the Ground System and the Observatory and cannot be suitably verified during GRT or Observatory Testing will be performed during ETEs*
 - *Note: This is to be a small subset of all MSS requirements*

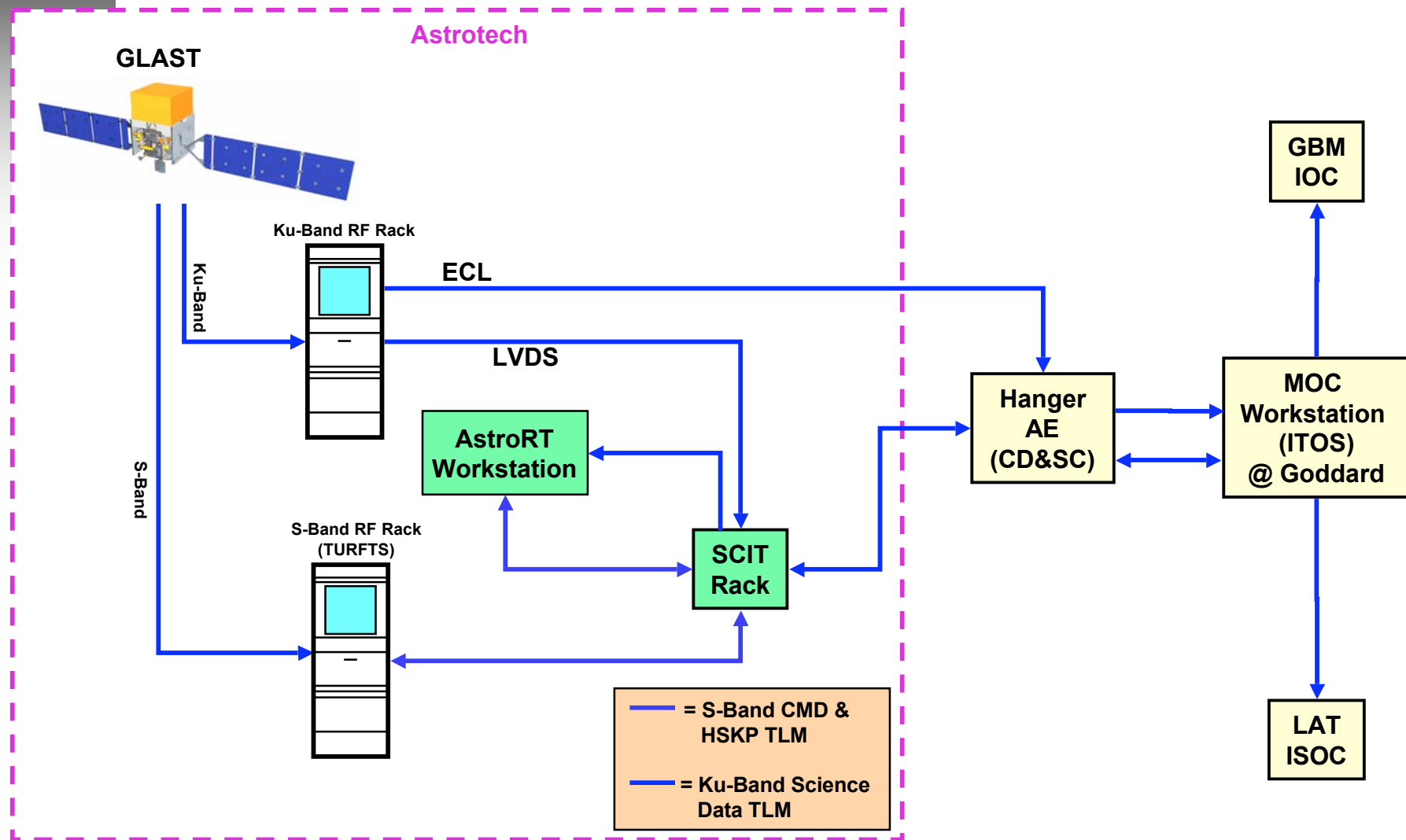


End-to-End Test Configuration





ETE Configuration - Launch Site





End-to-End Test Objectives



- ▶ ***ETE Test - 1 Basic Observatory T&C (02/08/06)***
- ▶ ***ETE Test - 2 Basic Command/Memory Management (05/04/06)***
- ▶ ***ETE Test - 3 Basic Observatory Operations (06/15/06)***
- ▶ ***ETE Test - 4 Advanced Operations (08/24/06)***
- ▶ ***ETE Test - 5 Regression & Contingencies (10/16/06)***
- ▶ ***Launch Site ETE – Launch Operations (02/01/07)***



Discrepancy Management/Tracking



- ▶ ***DRB will be chaired by the GSOM***
 - *DRB consists of representatives from each of the Ground System Elements and Operations Personnel*
- ▶ ***Ground System level discrepancies will be recorded and managed through the Discrepancy Management System***
 - *Discrepancies will be categorized by element and test*
 - *Ground System Discrepancy Review Board (DRB) will disposition DR's, allocate severity based on criticality of the functionality*
- ▶ ***The GRTT and DRB will work closely together, but essentially will serve two different purposes:***
 - *The GRTT will primarily plan and analyze tests*
 - *The DRB will evaluate and track individual system anomalies and associated repairs*



Test Mapping to Builds/Releases



- ▶ **Test Schedule has been coordinated with all elements build capabilities to ensure compatibility with test objectives**

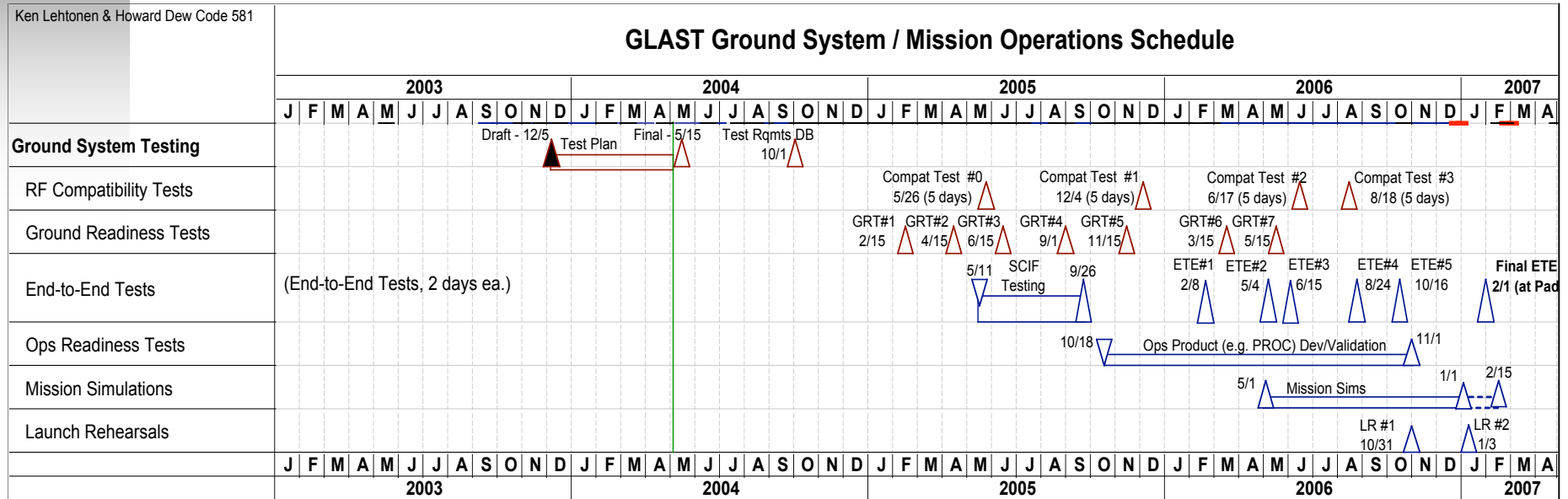
- *Table indicates which Builds are available for each test if required*

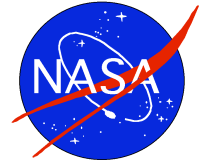
- *Note: As of GRT 6, all Elements will use Launch Capabilities for testing*
 - *Note: A Final ETE will be performed at the Launch site*
 - *Builds versus Test is based on 4/16/04 Ground System schedule*

Test	Build/Release			
	MOC	LAT ISOC	GBM IOC	GSSC
GRT 1	1	-	-	2
GRT 2	1	1	1.2	2
GRT 3	1	1	1.3	3
GRT 4	2	2	2.1	4
GRT 5	2	2	2.2	4
ETE 1	2	3	2.2	4
GRT 6	3	3	2.2	4
ETE 2	3	3	2.2	4
GRT 7	3	3	2.2	4
ETE 3	3	3	2.2	4
ETE 4	4	3	2.2	4
ETE 5	4	3	2.2	4



Test Schedule





Backup Slides

Detailed Test Objectives



Ground Readiness Test 1 (1 of 2)



- *GRT-1 Basic Command and Telemetry to PSS Connectivity (2/15/05)*
- *Participants*
 - MOC, FOT, WSC, SAI, IOTs, GSSC, NASCOM/NISN
- *Pre-Test*
 - MOC to ingest T&C Database from Spectrum Astro
 - MOC to ingest partial T&C Database from IOTs
 - Perform CCB and CM control of T&C Database
 - *MOC, PSS and GSSC to have identical PDB*
 - *Observatory Telemetry and Command Database Updates*
 - Black phone schedule of WSC resources
 - Briefing messages
 - Install PSS and perform connectivity check with GSFC
 - Perform connectivity check with GSSC
 - EGSE required – PSS, BitAlyzer
- *Test Objectives*
 - MOC will verify proper handling of GLAST T&C database
 - *Requires sufficient observatory and instrument telemetry to fill 151 HK stream and 2.5 MB playback*
 - Real-time (RT) T&C data flow between MOC and a S/C simulator and instrument data from WSC to MOC
 - *Real-time S-Band data from the PSS*
 - *MOC to decom subset of all data types*
 - *MOC to send NOOP commands to the PSS*
 - » Capture and compare bits at PSS
 - Dump S-Band HK data
 - *Dump HK partition of the PSS*



Ground Readiness Test 1 (2 of 2)



- *GRT-1 Basic Command and Telemetry to PSS Connectivity (2/15/05)*
- *Test Objectives continued ...*
 - *MOC to create Level-0 file of observatory HK data*
 - *MOC Archive of level-0 data*
 - *MOC to transfer Level-0 HK data files to GSSC (GSSC to ingest)*
 - *Full HK Level-0 data file transfer*
 - » Notifications, acknowledgements and dispositions
 - » Ensure delivery to proper directories
 - *GSSC ingest HK Level-0 data into archive*
 - *GSSC sends re-transmission request to MOC*
- *Post Test*
 - *Test Director Summary*
 - *Brief synopsis of test within 24-hours of execution*
 - *Summary report*
 - *Data received and status*
 - *Problems encountered*
 - *Cleanup Archive*



Ground Readiness Test 2 (1 of 2)

- *GRT-2 Basic S-Band Operations (4/15/05)*
- *Participants*
 - MOC, FOT, WSC, SAI, IOTs, GSSC, FDF, NASCOM/NISN
- *Pre-Test*
 - MOC to generate PDB
 - MOC to ingest T&C Database from Spectrum Astro
 - MOC to ingest T&C Database from IOTs
 - Perform CCB and CM control of T&C Database
 - MOC, PSS, IOTs and GSSC to have identical PDB
 - Observatory Telemetry and Command Database Updates
 - Basic planning & scheduling (P&S) S-Band activities with WSC
 - Schedule WSC resources using SWSI
 - Briefing messages
 - FDF to provide orbital products to the MOC for distribution as required
 - MOC to distribute FD products
 - EGSE required – PSS, BitAlyzer
- *Test Objectives*
 - Regression Test GRT#1 T&C flows
 - Basic S-Band planning and scheduling with WSC
 - Flow S-band data from PSS through TDRSS
 - Flow RT HK data
 - Dump HK SSR partition on PSS
 - P&S plans from IOC's to GSSC
 - Ingest commands and memory loads from IOCs
 - Full file transfer



Ground Readiness Test 2 (2 of 2)



- *GRT-2 Basic S-Band Operations (4/15/05)*
- *Test Objectives continued ...*
 - *Plans/activities to MOC from GSSC*
 - *Pre-Planned Science Timelines*
 - *GSSC to send timelines and memory loads to MOC*
 - *Full file transfer*
 - *MOC builds and uplinks simple stored command loads to simulator (PSS)*
 - *Instrument Memory Loads and Commands (LAT and GBM)*
 - *Flow RT HK data to LAT ISOC*
 - *Real-Time Housekeeping Data*
 - *MOC to transfer Level-0 HK to GBM and LAT*
 - *Level-0, Notifications, Acknowledgements and Dispositions*
 - *Ensure files are sent to the proper directories*
 - *FDF to perform DOWD*
- *Post Test*
 - *Test Director Summary*
 - *Brief synopsis of test within 24-hours of execution*
 - *Summary report*
 - *Data received and status*
 - *Problems encountered*
 - *Cleanup Archive*



Ground Readiness Test 3 (1 of 2)



- *GRT-3 Basic Ku-Band Operations (6/15/05)*
- *Participants*
 - MOC, FOT, WSC, SAI, LISOC, GIOC, IOTs, GSSC, FDF, NASCOM/NISN
- *Pre-Test*
 - MOC to generate PDB
 - MOC to ingest T&C Database from Spectrum Astro
 - MOC to ingest T&C Database from IOTs
 - Perform CCB and CM control of T&C Database
 - MOC, PSS, IOTs and GSSC to have identical PDB
 - Observatory Telemetry and Command Database Updates
 - Basic planning & scheduling (P&S) S-Band activities with WSC
 - Schedule WSC resources using SWSI
 - GSSC and MOC exchange contact and request schedules for TDRSS
 - Briefing messages
 - FDF to provide orbital products to the MOC for distribution as required
 - GSSC and IOCs to ingest FD products from the MOC
 - EGSE required – PSS, BitAlyzer
- *Test Objectives*
 - Regression Test GRT#2 T&C flows
 - S-Band Burst Alert and Housekeeping Telemetry flows through TDRSS
 - » Generated by simulator, sent through TDRSS via SOC at Goddard
 - MOC forwards Burst Alert's to the Burst Alert Processors (BAPs), which forwards to the GCN
 - GSSC to support BAP Operations
 - GSSC integrates IOC commands/memory loads into timeline



Ground Readiness Test 3 (2 of 2)



- *GRT-3 Basic Ku-Band Operations (6/15/05)*
- *Test Objectives Continued ...*
 - *MOC ingests science timeline from the GSSC*
 - *MOC delivers integrated observatory timeline to GSSC*
 - *GSSC ingests integrated observatory timeline from MOC*
 - *Commanding through TDRSS (to the simulator)*
 - *GFEP and Ku-Band basic T&C flows*
 - *Flow RT HK data*
 - *Command through S-Band*
 - *Level-0 data processing performed on science data*
 - *IOCs process Science Level-0 into Level-1 products*
- *Post Test*
 - *Test Director Summary*
 - *Brief synopsis of test within 24-hours of execution*
 - *Summary report*
 - *Data received and status*
 - *Problems encountered*
 - *Cleanup Archive*
 - *Evaluate planning timeline exchange between MOC, GSSC and IOCs and execution*



Ground Readiness Tests 4 (1 of 2)



- *GRT-4 Ground Station Operations (9/1/05)*
- *Participants*
 - MOC, FOT, USN, SAI, LISOC, GIOC, IOTs, GSSC, FDF, GCN, NASCOM/NISN
- *Pre-Test*
 - MOC to generate PDB
 - MOC to ingest T&C Database from Spectrum Astro
 - » Including Instrument T&C Database
 - MOC to distribute PDB to all participants
 - Perform CCB and CM control of T&C Database
 - MOC, PSS, IOTs and GSSC to have identical PDB
 - Observatory Telemetry and Command Database Updates
 - Basic planning & scheduling (P&S) S-Band activities USN
 - Briefing messages
 - FDF to provide orbital products to the MOC for distribution as required
 - MOC to distribute FD products for ingest by all test participants
 - EGSE required – PSS, BitAlyzer
- *Test Objectives*
 - Main focus is T&C data flows to/from the ground stations
 - RT S-Band Hk
 - S-Band command
 - Planning and Scheduling with USN
 - Ingest timelines, memory loads into GSSC databases (no impact on ground scheduling)
 - Spacecraft and instrument housekeeping data
 - S-band burst alerts through the Ground Stations



Ground Readiness Tests 4 (2 of 2)



- *GRT-4 Ground Station Operations (9/1/05)*
- *Test Objectives continued ...*
 - *S-band HK recorder dumps*
 - *Level-0 processing of S-Band HK dump data*
 - *MOC sends Level-0 HK data to IOC's*
 - *IOCs perform ingest of HK data level-0 files*
 - *MOC sends Level-0 HK data to GSSC*
 - *MOC provides burst alert data to GBM IOC and to BAP*
 - *BAP sends GCN notice to GCN*
- *Post Test*
 - *Test Director Summary*
 - *Brief synopsis of test within 24-hours of execution*
 - *Summary report*
 - *Data received and status*
 - *Problems encountered*
 - *Cleanup Archive*



Ground Readiness Test 5 (1 of 2)



- *GRT-5 Science Operations (11/15/05)*
- *Participants*
 - MOC, FOT, WSC, USN, SAI, LISOC, GIOC, IOTs, GSSC, FDF, GCN, NASCOM/NISN
- *Pre-Test*
 - MOC to generate PDB
 - MOC to ingest T&C Database from Spectrum Astro
 - » Including Instrument T&C Database
 - MOC to distribute PDB to all participants
 - Perform CCB and CM control of T&C Database
 - MOC, PSS, IOTs and GSSC to have identical PDB
 - Observatory Telemetry and Command Database Updates
 - Planning & scheduling (P&S) Ku and S-Band activities with WSC
 - Schedule WSC resources using SWSI
 - GSSC and MOC exchange contact and request schedules for TDRSS
 - Briefing messages
 - FDF to provide orbital products to the MOC for distribution as required
 - GSSC and IOTs to ingest FD products from the MOC
 - More complex P&S among IOTs, GSSC and MOC
 - Bring in supporting spacecraft and instrument memory loads
 - EGSE required – PSS, BitAlyzer, Data Challenge Science Data
- *Test Objectives*
 - Flow Ku –Band data from WSC to MOC
 - Dump Science SSR partition on PSS
 - Flow instrument Science data from Data Challenges through PSS to MOC



Ground Readiness Test 5 (2 of 2)



- *GRT-5 Science Operations (11/15/05)*
- *Test Objectives Continued ...*
 - *MOC to send KU band level-0 files to the IOCs*
 - *Need simulated science data to be processed by IOC algorithms*
 - *Level 1 and Level 2 processing sent to GSSC from IOCs*
 - *GSSC to ingest Level 1,2 data from IOCs*
 - *Full file transfer*
 - *Ingest into databases*
 - *Burst alerts on Ku-band*
 - *BAP and GBM IOCs send GCN notices to the GCN*
 - *Diagnostic data on Ku-band*
 - *Use Voice Networks for communication between elements*
- *Post Test*
 - *MOC generate as-flown timeline and send to GSSC*
 - *GSSC Ingest as-flown timeline from MOC and compare versus science timeline*
 - *LAT IOC sends GCN notices to the GCN*
 - *Test Director Summary*
 - *Brief synopsis of test within 24-hours of execution*
 - *Summary report*
 - *Data received and status*
 - *Problems encountered*
 - *Cleanup Archive*



Ground Readiness Test 6 (1 of 2)



- *GRT-6 Contingency Operations (3/15/06)*
- *Participants*
 - MOC, FOT, WSC, USN, KSC, SAI, LISOC, GIOC, IOTs, GSSC, FDF, GCN, NASCOM/NISN
- *Pre-Test*
 - MOC to generate PDB
 - MOC to ingest T&C Database from Spectrum Astro
 - MOC to ingest T&C Database from IOTs
 - MOC to distribute PDB to all participants
 - Perform CCB and CM control of T&C Database
 - MOC, PSS, IOTs and GSSC to have identical PDB
 - Observatory Telemetry and Command Database Updates
 - Basic planning & scheduling (P&S) Ku and S-Band activities with WSC
 - Schedule WSC resources using SWSI
 - GSSC and MOC exchange contact and request schedules for TDRSS
 - Basic planning & scheduling (P&S) S-Band activities USN, KSC
 - Briefing messages
 - FDF provide orbital products to the MOC
 - GSSC and IOTs to ingest FDF products from the MOC
 - EGSE required – PSS, BitAlyzer, Data Challenge Science Data
- *Test Objectives*
 - Similar to GRT#5 with contingencies added
 - Cleanup and Regression Testing
 - GSSC to Operate backup Level 0 pipelines
 - GSSC processes Level-0 into Level-1 and 2 products
 - Compare with IOT processing



Ground Readiness Test 6 (2 of 2)



- *GRT-6 Contingency Operations (3/15/06)*
- *Test Objectives Continued ...*
 - *ToO Operations*
 - *GSSC to Create ToO order*
 - *GSSC to send ToO order to MOC*
 - *GSSC and MOC exchange notifications*
 - *MOC perform real-time TDRSS scheduling*
 - *MOC to transmit ToO commands to PSS via TDRSS*
 - *Red limit alarm and burst alert notification paging*
 - *IOCs send instrument engineering command requests directly to MOC*
 - *MOC failover scenarios*
 - *User notification of anomalies*
 - *Contingency S-Band dumps at Ground Stations*
 - *Use Voice Networks for communication between elements*
- *Post Test*
 - *MOC generate anomaly reports*
 - *Note: Anomalies will be data losses and NOT spacecraft related*
 - *GSSC ingest anomaly reports from MOC*
 - *Full file transfer*
 - *Ingest into database*
 - *Summary report of data received and status*
 - *Cleanup Archive*



Ground Readiness Test 7

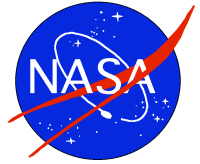


- *GRT-7 Regression (5/15/06)*

- *Clean-up/regression testing*
- *Autonomous Operations*



Detailed End-to-End Test Objectives



► ***ETE Test - 1 (Basic Observatory T&C)***

- *RT Observatory HK telemetry – all rates, SN and GN*
- *Use TDRSS link, Ku and S-band data*
- *Use CTV and/or RF Suitcase to handle GN interface*
- *RT spacecraft and instrument commanding – all rates and types*
- *SSR operations*
- *Instrument science data being generated*
- *Stored command loads (ATS & RTS)*
 - *Simple spacecraft and instrument commands*
- *Basic diagnostic data*
- *Provide Level 0 files to IOC's (post-test)*
- *IOC's generate Level 1 data products and provide to GSSC*



Detailed End-to-End Test Objectives

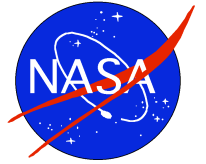


► ***ETE Test - 2 (Basic Command/Memory Management)***

- *ETE-1 plus...*
- *Memory/FSW load uplink (S/C and instruments)*
 - *Tables and FSW patches*
- *Memory dumps (S/C and instruments)*
 - *Tables and FSW patches*
- *Stored command loads, more complex than ETE-1*
 - *S/C and instrument commands*
 - *Observatory timeline/load input IOC's to GSSC to MOC*
- *RT Observatory HK TLM packets to LAT IOC*
- *Burst alert telemetry (MOC-BAP-GCN FE)*



Detailed End-to-End Test Objectives



► *ETE Test - 3 (Basic Observatory Operations)*

- *ETE-1&2 plus...*
- *Autonomous Re-points (AR's)*
- *TOO commanding*
- *ATC buffer handover*
- *Burst Alert telemetry to GIOC BAP*
- *Clock management*
- *Orbit determination (FDF-MOC)*
 - *Tracking data from SN to FDF*
 - *GPS orbit data from MOC to FDF*
 - *Ephemeris loads to S/C (S/C and TDRSS)*



Detailed End-to-End Test Objectives



► ***ETE Test - 4 (Advanced Operations)***

- *ETE-1 thru 3 plus...*
- *L&EO Timeline segments (e.g., subsystem activation)*
- *Spacecraft-unique operations (not simulated adequately by HotBench)*
- *Subsystem failovers (e.g., A to B-side CPU)*
- *More advanced/complex FSW patches/updates*

► ***ETE Test - 5 (Regression & Additional Contingencies)***

- *ETE-1 thru 4 plus...*
- *Last check before S/C ship for items such as:*
 - *Ground system fixes/enhancements*
 - *Revised/new PROCs*
 - *FSW updates*
 - *T&C database updates*